WORK PLAN

WMA Mini-Grant Research Project Proposal

University of California
On behalf of the Lake WMA
January 1, 2011-December 2011

Contract Lead Group and Contact Person(s) (name, phone number, email, and address):

Sandra Stevens
Associate Director
Sponsored Programs
1850 Research Park Drive, Ste 300
Davis, CA 95618
smstevens@ucdavis.edu
530-754-7917

Project Lead(s) for project and contract reporting and invoicing: (name, phone number, email, and address):

Paul Aigner
Resident Co-director and Project Scientist
University of California Davis, Donald and Sylvia McLaughlin Natural Reserve
26775 Morgan Valley Rd.
Lower Lake, CA 95457
paaigner@ucdavis.edu
707-995-9005

Howard Cornell, Professor and Susan P. Harrison, Professor
Department of Environmental Science and Policy
One Shields Ave
University of California
Davis, CA 95616

Karli Holler
Natural Reserve System/John Muir Institute of the Environment
The Barn
One Shields Avenue
University of California
Davis, CA 95616-8527
kjholler@ucdavis.edu
530-754-7990

This project is in affiliation with what WMA group or groups?

This project will be under the auspices of the Lake County WMA. Serpentine grasslands have not historically been a management priority for the Lake County WMA. Instead, the Lake County WMA has naturally focused on aquatic and riparian weeds associated with Clear Lake and its tributaries, and with Scotch Broom, an invader that is particularly problematic in the forested northern part of the county. In 2009, staff from the McLaughlin Reserve began participating actively in the Lake County WMA, partly to draw attention to the prevalence and conservation value of serpentine grasslands in the county and to promote the management of invasive species that impact these grasslands. This project will be part of a larger effort to promote serpentine grassland conservation within Lake County. Over the past several years, staff members from the McLaughlin Reserve have worked with landowners in the southeastern part of the county to coordinate the management of barbed goat grass and other invasive species in both serpentine and non-serpentine grasslands. For more than five years, the reserve has hosted regular public outreach programs to promote awareness of invasive species ecology and management. For two decades, the McLaughlin Reserve has served as a center for academic research on invasive species and plant ecology in Lake County, particularly in relation to serpentine soils. This project will be a first step towards drawing ongoing research, management, and outreach efforts into the mantle of the Lake County

WMA, and will thus increase effectiveness of the WMA in competing for scarce management resources and for addressing the weed management concerns of the citizens of the Lake County.

List what other Noxious and Invasive Weed Research has been conducted by you or your group:

Currently we are collaborating on a number of studies related to the invasion of barbed goat grass (*Aegilops triuncialis*) including an assessment of how the spread of barbed goat grass impacts the native plant community, how well various treatment techniques control goat grass and restore native plant species diversity, and how ecological factors such as soil and interspecific competition affect the spread of goat grass. These studies are entering their third year and we expect to begin disseminating results within 6 months.

Dr. Aigner has previously studied the effect of invasive plants on pollination service to a native plant in a California coastal dune ecosystem:

Aigner, P.A. 2004. Ecological and genetic effects on demographic processes: pollination, clonality and seed production in *Dithyrea maritima*. Biological Conservation 116:27-34.

Dr. Harrison is one of the preeminent experts in the ecology of California's serpentine grasslands. For over a decade she has studied how soil, fire, grazing, and roads influence the distribution of invasive species in grasslands. Representative publications include:

Harrison, S. 1999. Native and alien species diversity at the local and regional scales in a grazed California grassland. Oecologia 121:99-106.

Harrison, S., K. Rice, and J. Maron. 2001. Habitat patchiness promotes invasion by alien grasses on serpentine soil. Biological Conservation. 100:45-53.

Harrison, S., C. Hohn, and S. Ratay. 2002. Distribution of exotic plants along roads in a peninsular nature reserve. Biological Invasions 4:425-430.

Harrison, S., J.B. Grace, K.F. Davies, H.D. Safford, and J.H. Viers. 2006. Invasion in a diversity hotspot: Exotic cover and native richness in the California serpentine flora. Ecology 87:695-703

Proposed Project(s)

Project Title: How is the diversity and abundance of native arthropods affected by the spread and management of barbed goat grass (*Aegilops triuncialis*) in serpentine grasslands?

Project Goal (1/2 page max)

Serpentine grasslands are well known for being relatively free of invasive species that typify other California grasslands. In the past two decades the special status of serpentine grasslands as strongholds of native plant diversity has been threatened by the rapid spread of barbed goat grass, a Eurasian annual grass that is unique in its tolerance of serpentine soils. Our goal is to assess how native arthropod diversity is affected by this invasion and by management activities to control it. There are compelling reasons to worry that goat grass may have strong negative effects on native arthropods. First, because serpentine soils serve as a refuge for native California grassland plants, they likely serve as a refuge for the arthropods that rely on these plants. For example, the endangered Bay checkerspot butterfly (*Euphydrya editha bayensis*) is now restricted to only a few serpentine grasslands in the San Francisco Bay area where its host plant (the native forb *Plantago erecta*) persists (Harrison and Viers 2007), and the persistence of this host plant is now threatened by the spread of goat grass (Niederer 2007). Second, work by April Boulton and others (2005) has shown that native ant diversity in serpentine grasslands is negatively correlated with plant biomass. Goat grass, by substantially increasing above ground biomass, is likely to have a negative effect on many ants.

Our project will piggy-back on existing goat grass research and management that is occurring at the McLaughlin Reserve, at the junction of Lake, Napa, and Yolo Counties. We will sample arthropods in small experimental plots that are undergoing treatments to control goat grass (mowing, hand pulling, herbicide) to determine how various control techniques affect the arthropod community. The experimental framework will allow us to determine whether changes in the arthropod community are a direct result of the treatments (e.g., effects of herbicide use) or are indirect result of changes in plant species composition. We will also sample arthropods in large areas that are either uninvaded by goat grass, infested with goat grass, or have undergone various treatment regimes to control goat grass. This will allow us to determine whether effects on arthropods are dependent on the spatial scale of the invasion or the treatment. The results of this study will help us develop a more holistic management strategy for goat grass: one that focuses not only on removing goat grass, but also on reestablishing patterns of native plant and animal species diversity and natural ecosystem processes.

What are the project's long-term benefits and/or local, regional or statewide significance (8 sentence Max):

Serpentine grasslands are a resource of statewide significance. They are unique in California in that most invasive species cannot tolerate the extreme chemistry of serpentine soils (low nutrients, high magnesium and heavy metals). On more benign soils, which dominate California, native grassland species have been almost completely replaced by Eurasian annual grasses. Thus, serpentine grasslands have become refuges for native grasses and forbs, which can tolerate the harsh conditions, and provide a rare window to the pre-European condition of California grasslands. Serpentine grasslands are also home to a suite of endemic plant species, many of which have extremely limited distributions. This project will contribute to the long-term conservation of serpentine grasslands by providing a better understanding of the arthropod diversity within these grasslands and by providing guidelines for managing invasive plants while at the same time protecting native arthropod diversity. Results of the project will be disseminated to managers of serpentine grasslands throughout the state, and will be of direct benefit to entities such as the Bureau of Land Management, the Marin County Open Space District, the Santa Clara County Open Space Authority, all of which are actively managing barbed goat grass invasions.

Priority Topic Area Being Addressed (from request for proposal announcement, 8 sentence Max):

The project addresses the need for understanding the connection between wildlife and invasive plants. In serpentine grasslands, barbed goat grass may affect populations of terrestrial arthropods, small mammals, and birds, and these effects may in turn cause changes in ecosystem processes (such as herbivory or seed predation) that influence the spread and persistence of goat grass. Effects on native arthropods are predicted to be pronounced and negative, because many arthropods (and particularly insects) are closely associated with particular food plants or with the unique physiognomy of serpentine grasslands. This study will investigate the effect of the invasion and its management on abundance and diversity arthropods. In the future we may investigate how these changes in turn affect arthropod-mediated processes such as pollination, herbivory, and seed predation.

Please Describe your in-kind contributions toward research project(s) (4 sentence max):

Here we request $4520 for a student lab technician (likely a UC Davis entomology student) to sort and identify arthropods. We will contribute all labor for the field component of the study and all labor required for analyzing, publishing, and otherwise disseminating results at an estimated total value of $7961. Field work will be conducted by Dr. Aigner and five field assistants (interns from the Student Conservation Association). All materials and supplies required for the study are already available at the reserve and are of minor value. They are not considered part of the formal in-kind contribution because of the University's onerous requirements for documenting non-personnel contributions.

Project Objectives, Tasks and Methods

OVERALL OBJECTIVE (4 sentence Max):

Our overall objective is to estimate and compare arthropod abundance and species diversity in serpentine grasslands that are not yet invaded by barbed goat grass, heavily infested with barbed goat grass, or now relatively free of barbed goat grass after having undergone various types of treatment for at least two years. Arthropod sampling will occur in the spring and summer in two situations: (1) in 4-m^2 experimental plots that were assigned to be experimental controls or to receive one of nine treatments to remove goat grass for three consecutive years, and (2) in large areas (>0.1 hectare) that are either invaded, uninvaded, or have been actively treated for the past two to five years. The experimental plots provide us with true randomization and replication, but inference from them is limited by their small size and proximity to one another (i.e., arthropods may move among treatment plots). We will not have true replication for all sampling within large areas (e.g., treatments such as prescribed burning may have only occurred in one or two areas) but the information from this sampling will allow us to validate the experimental results and assess scale dependence in the response of the arthropod community.

Task 1 (2 sentence Max): Arthropod and plant sampling in the existing goat grass treatment experiment.

Methods (8 sentence Max)-The goat grass treatment experiment was established in 2008 and contains 100 2m x 2m experimental plots that were heavily infested with barbed goat grass. Ten plots are experimental controls; the remaining 90 were assigned to one of the following treatments: hand pulling, mowing with a gas-powered string trimmer, late-season application of Roundup (glyphosate), early-, mid-, or late-season application of Fusliade II (fluazifop), and early-, mid-, or late-season application of Envoy+ (clethodim). Treatments were first applied in 2008 and were repeated in 2009. All treatments except the early-season herbicide applications will be repeated in 2010. The experiment is a randomized block design, with blocks defined by initial goat grass density. In the spring and summer of 2010 we will

sample arthropods using pan traps and pitfall traps. One pan trap and one pitfall trap will be placed near the center of each plot and sampled weekly. Arthropods will be stored in alcohol. In each plot plant species composition and cover will be measured with a point intercept technique.

Task 2 (2 sentence Max): Arthropod sampling in large areas of invaded, uninvaded, and treated grassland.

Methods (8 sentence Max)-The McLaughlin Reserve includes a mosaic of serpentine and non-serpentine grasslands with approximately 100 hectares of serpentine grassland invaded by barbed goat grass. Goat grass management began in 2004 and currently 30-50 hectares/year are treated with of a combination of prescribed burning, mowing, hand pulling, and spraying with Envoy or Fusilade. We will identify grassland patches <0.1 hectare that are either uninvaded by goat grass, infested with goatgrass, or nearly free of goatgrass after two or more years of treatment. Within each category we will set out 20 pan traps and 20 pitfall traps, which will be checked weekly.

Task 3 (2 sentence Max): Sample processing.

Methods (8 sentence Max)-Voucher specimens will be prepared (pinned or in alcohol, as appropriate) for all arthropod morpho-species encountered (i.e., specimens that appear identical in a dissecting microscope whether or not their true species identity can be ascertained) and will be deposited at the UC Davis Bohart Museum and in the McLaughlin Reserve collection. Individual samples will be sorted and all specimens will be identified to family and species or morpho-species.

Performance Measures

How will you assess and/or analyze your results (8 sentence Max)? For each sample we will compute native species diversity and native species abundance. Diversity and abundance will be compared among treatment levels using analysis of variance. We will conduct additional analyses of abundance for any species or morpho-species that is particularly common. For the subset of arthropod species that are common across treatments we will use multivariate techniques, such as Multivariate Analysis of Variance, to determine whether the composition of the arthropod community varies among treatments. In the treatment experiment (Task 1), goat grass cover and native forb cover will be used as covariates in assessing treatment effects. This will allow us to test whether the treatments have a direct effect on arthropods independent from their indirect effect through changes in the plant community. Data from Task 1 and Task 2 will be analyzed separately and the congruency between the results will be assessed qualitatively.

How will your results be disseminated (4 sentence Max)? Results will be disseminated through traditional means such as publishing in scientific journals and presenting at professional meetings (e.g., Cal-IPC). In addition we will disseminate results directly to other managers of serpentine grasslands, with whom we have regular contact (e.g., from the agencies mentioned under project benefits). The research and its results will also be incorporated into public programs (lectures, hikes, and volunteer weed management days) that are offered at the McLaughlin Reserve and through the Lake County WMA.

Literature cited

Boulton, A. M., K. F. Davies, and P. S. Ward. 2005. Species richness, abundance, and composition of ground-dwelling ants in northern California grasslands: Role of plants, soil, and grazing. Environmental Entomology **34**:96-104.

Harrison, S. and J. H. Viers. 2007. Serpentine Grasslands. Pages 145-155 *in* M. R. Stromberg, J. Corbin, and C. D'Antonio, editors. California grasslands: ecology and management. University of California Press, Berkeley.

Niederer, C. 2007. Barb goatgrass (*Aegilops triuncialis*) at Coyote Ridge: Management report, 2007. Unpublished report. Creekside Center for Earth Observation